Evaluating Train Rescheduling Methods to Reflect Passenger Dissatisfaction

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In Japan, railways play a vital role in transporting people in and between metropolitan areas. In many instances, trains are operated every few minutes to transport a vast number of commuters, yet Japanese railway operators have a worldwide reputation for punctuality. However, in recent years, there has been a long-term rise in the frequency of "transport disorder," defined as train delays of 30 minutes or more, on Japanese urban railways. This has become a serious social problem. The problem manifests itself in the form of significant train delays spread over a wide service area. This can be affected by recession-related suicides on the line and by the expansion of through-operations between different railways, intended to enhance travel convenience.

In order to restore disrupted services, a series of modifications to the current train schedule has to be completed. Such a task is called train rescheduling.

However, currently we do not have refined and established criteria available for this task because there are too many aspects to consider such as the scale of train traffic disruption and the extent of passengers' inconvenience. The effect of train rescheduling has been measured in the past based on such indices as "train delays" and "time required to restore normal train traffic." Such indices are useful to macroscopically assess the effect of disordered train operation, but not to measure detailed change brought about train rescheduling. To assess the effect of train operation disorder more precisely from the viewpoint of the passengers, attempts have been made in recent years to develop evaluation indices to reflect the dissatisfaction and inconvenience of passengers. However, the proposals to date do not directly deal with passenger dissatisfaction as it applies to rescheduling train operation. It has not been clarified either, to what extent they correspond to the dissatisfaction of those who actually encounter disruption in the service. Under the circumstances, therefore, RTRI implemented the following developmental activities.

(1) Measurement of the dissatisfaction of those who have been involved in train disruption through a questionnaire survey on the Internet.
(2) Construction of a model to explain the hitherto unknown process in which dissatisfaction is generated. We call it Passenger dissatisfaction determinant model as shown in Fig 1. The model is constructed based on the data collected in (1). It is also clarified that evaluation by passengers of the information provided by railway operators largely affects the dissatisfaction against the railway services on the day.
(3) Proposed formulae (Table 1) to calculate passenger dissatisfaction by using data collected in (1).
(4) Development of a method to evaluate the train rescheduling. By introducing a simulation system that can simulate the behaviour of passengers, we can calculate and visualize the values of indices as shown in Fig 2.

This method can quantify the effects of the detailed modifications that compose the train rescheduling. Consequently, it is applicable to post-analysis of the already implemented train rescheduling, and can provide useful knowledge in sharing problems and knowledge among train dispatchers.

We would like to conduct further surveys on different lines and/or in several distinct types of disruption in order to improve the precision of passenger dissatisfaction estimation. We also plan to develop a refined simulation technique to achieve precise and fast predictions of train traffic and passenger behaviour.

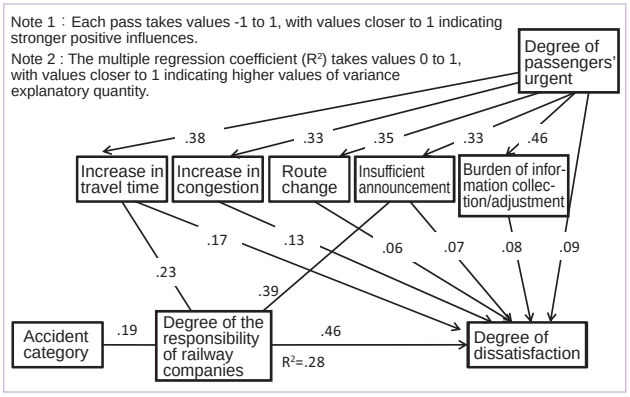

Fig. 1 Passenger dissatisfaction determinant model

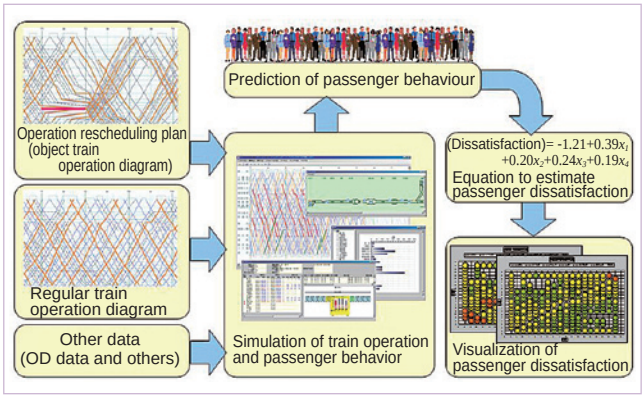

Fig. 2 The method to evaluate the train operation rescheduling service to reflect passenger dissatisfaction

Table 1 Formulae to evaluate the train operation rescheduling plans

Passenger dissatisfaction = $-1.21 + 0.39\,X_1 + 0.20X_2 + 0.24X_3 + 0.19X_4$ (R^2=0.30)
X_1: Subjective quantity for the increase in the required time (r=0.55) X_1 = 2.69+2.46 {log (1+required time on the day)-log(1+normally required time)}+0.26(cancellation of train operation)+0.32(degree of haste)
X_2: Subjective quantity for the increase in the waiting time (r=0.65) X_2 = 2.20+1.12{log(1+waiting time on the day)−log(1+normal waiting time)}+0.22(cancellation of train operation)+0.32(destination change)+0.23(degree of haste)
X_3: Subjective quantity for the increase in the degree of the congestion in trains (r=0.62) X_3 = 2.37+0.02 {log(1+degree of congestion on trains on the day)-log(1+normal degree of congestion on trains)}+0.27(cancellation of train operation)+ 0.28(degree of haste)
X_4: Subjective quantity for the increase in the frequency of transfer (r=0.79) X_4 = 1.89+1.44 {log(1+frequency of transfer on the day)-log(1+normal frequency of transfer)}+0.34(cancellation of train operation)+0.14(degree of haste)